

REMARKS

The following responds to the rejections set forth by the Examiner in the Office Action of September 7, 2006.

I. Claim Rejections Under 35 U.S.C. § 102(b)

In the Office Action of September 7, 2006, the Examiner rejected claims 1-5 as being anticipated by U.S. Patent No. 6,214,731, issued on April 10, 2001 to Nogami et al. (hereinafter “Nogami”). The Examiner also rejected claims 1-4, 12, 19, 21, and 22 as anticipated by U.S. Patent No. 6,300,244, issued on October 9, 2001 to Itabashi et al. (hereinafter “Itabashi”). It is believed that the Examiner’s rejections of claims 1-4 and 12 have been overcome because claim 1 has been amended to include the elements of claim 7. Claims 19-22 have been cancelled and the Examiner’s rejection of these claims is now moot.

Claim 5 has been combined with the elements of claim 1 and rewritten as new claim 59. Accordingly, the Examiner’s rejection of claim 5 will be discussed with reference to new claim 59, and claims 60-62 that depend therefrom. New claim 59 is directed to a method for depositing copper overlying a work piece. The method comprises the steps of depositing overlying the work piece a barrier layer having a surface and forming a protective layer that overlies the surface of the barrier layer and that inhibits oxidation of the surface. The protective layer is formed by exposing the surface to a sulfur-containing gas, a phosphorous-containing gas, or a combination thereof. Copper then is electrochemically deposited overlying the barrier layer. In contrast, nowhere does Nogami disclose forming a protective layer on the surface of a barrier layer by exposing the surface to a sulfur-containing gas, a phosphorous-containing gas, or a combination thereof. Accordingly, as Nogami does not disclose every element of new claim 59, it does not anticipate new claim 59 or new claims 60-62 that depend therefrom.

In the Office Action, the Examiner rejected claims 1-4, 7, and 8 as being anticipated by U.S. Publication No. 2002/0076929 by Lu et al., published on June 20, 2002 (hereinafter “Lu”). Claim 1 has been amended to include the elements of claim 7 and claim 7 has been cancelled. Accordingly, the Examiner’s rejection of claim 7 will be

addressed with respect to amended claim 1. Amended claim 1 is directed to a method for depositing copper overlying a work piece. The method comprises the steps of depositing overlying the work piece a barrier layer having a surface, forming a protective layer that overlies the surface of the barrier layer and that inhibits oxidation of the surface, removing the protective layer, and, after removing the protective layer, electrochemically depositing copper overlying the barrier layer.

In contrast, Lu does not disclose a method for depositing copper that includes forming a protective layer that overlies a barrier layer and that inhibits oxidation of the barrier layer surface and then removing that protective layer before electrochemically depositing copper. To the extent that Lu discusses forming a passivation layer overlying a seed layer, Lu does not discuss removing the passivation layer. The Examiner references paragraphs [0008] and [0018] of Lu; however, both of these paragraphs discuss the same procedure (paragraph [0008] in the “Summary of the Invention” and paragraph [0018] in the “Detailed Description”), that is, plasma treatment of a seed layer. Lu is clear that after the plasma treatment, an ECD copper film is then formed on the seed layer. Accordingly, as Lu does not disclose every element of amended claim 1, it does not anticipate amended claim 1, or claims 2-3, 6, and 8-14 that depend therefrom.

II. Claim Rejections Under 35 U.S.C. § 102(e)

The Examiner further rejected claims 1-5, 13, and 14 as being anticipated by U.S. Patent Publication No. 2003/0068887 by Shingubara et al., published on April 10, 2003 (hereinafter “Shingubara”). It is believed that the Examiner’s rejections of claims 1-4, 13, and 14 have been overcome because claim 1 has been amended to include the elements of claim 7.

As described above, claim 5 has been combined with the elements of claim 1 and rewritten as new claim 59. Accordingly, the Examiner’s rejection of claim 5 will be discussed with reference to new claim 59, and claims 60-62 that depend therefrom. New claim 59 is directed to a method for depositing copper overlying a work piece. The method comprises the steps of depositing overlying the work piece a barrier layer having a surface and forming a protective layer that overlies the surface of the barrier layer and

that inhibits oxidation of the surface. The protective layer is formed by exposing the surface to a sulfur-containing gas, a phosphorous-containing gas, or a combination thereof. Copper then is electrochemically deposited overlying the barrier layer. In contrast, nowhere does Shingubara disclose forming a protective layer on the surface of a barrier layer by exposing the surface to a sulfur-containing gas, a phosphorous-containing gas, or a combination thereof. Accordingly, as Shingubara does not disclose every element of new claim 59, it does not anticipate new claim 59 or new claims 60-62 that depend therefrom.

III. Claim Rejections Under 35 U.S.C. § 103(a)

In the Office Action of September 7, 2006, the Examiner rejected claim 6 as being unpatentable over Nogami. Claim 6 depends from claim 1. Accordingly, it is believed that the Examiner's rejection has been overcome because claim 1 has been amended to include the elements of claim 7.

The Examiner rejected claims 11, 23 and 24 as being unpatentable over Itabashi. Claim 11 has been amended to depend from new amended claim 1. Claims 23 and 24 have been cancelled. Accordingly, it is believed that the Examiner's rejections are rendered moot.

The Examiner rejected claims 6 and 11 as being unpatentable over Lu. Claims 6 and 11 have been amended to depend from claim 1, which has been amended to comprise the elements of claim 7. For a claim to be properly rejected for obviousness, the Examiner must show that the subject matter sought to be patented would have been obvious to one of ordinary skill in the art at the time the invention was made. As described above, Applicants respectfully submit that a *prima facie* case of obviousness has not been made out by the Examiner with respect to amended claim 1, and hence claims 6 and 11 that depend therefrom, because every critical element appearing in the claims is not disclosed by Lu.

The Examiner rejected claims 9, and 15-18 as being unpatentable over Lu in view of U.S. Patent Publication 2002/0076929 to Jung et al., published November 26, 2002 (U.S. Patent No. 6,486,055) (hereinafter "Jung"). Claim 9 depends from claim 8, which depends from amended claim 1. As explained above, Lu does not disclose a method for depositing copper that includes forming a protective layer that overlies a barrier layer and

that inhibits oxidation of the barrier layer surface and then removing that protective layer before electrochemically depositing copper. Jung also does not disclose a method for depositing copper that includes forming a protective layer that overlies a barrier layer and that inhibits oxidation of the barrier layer surface and then removing that protective layer before electrochemically depositing copper. Accordingly, Applicants respectfully submit that a *prima facie* case of obviousness has not been made out by the Examiner with respect to claim 9 because every critical element appearing in the claim is not disclosed by Lu in view of Jung. Claims 15-18 have been cancelled and the Examiner's rejection of these claims is now moot.

Claims 19 and 21 have been rejected by the Examiner as being unpatentable over Lu in view of U.S. Patent No. 6,764,950, issued July 20, 2004 to Noguchi et al. (hereinafter "Noguchi"). Claims 19 and 21 have been cancelled and the Examiner's rejection of these claims is now moot.

The Examiner also rejected claims 25-28 as being unpatentable over Lu in view of U.S. Patent No. 6,790,776, issued September 14, 2004 to Ding et al. (hereinafter "Ding"). Claim 25 has been combined with the elements of claim 1 and rewritten as new claim 55. Claims 26-28 have been amended to depend from new claim 55. Accordingly the Examiner's rejections will be discussed with reference to new claim 55, amended claims 26-28, and new claims 56-58. New claim 55 is directed to a method for depositing copper overlying a work piece. The method comprises the steps of depositing overlying the work piece a barrier layer having a surface, removing from the surface of the barrier layer a contaminant, an oxide, or both by applying to the surface of the barrier layer an initial cathode current pulse and, after the step of applying to the surface of the barrier layer an initial cathode current pulse, electrochemically depositing copper overlying the barrier layer. Nowhere does either Lu or Ding disclose applying an initial cathodic pulse to the surface of the barrier layer, followed by electrochemical deposition. To the extent that Ding discusses the use of a cathode, Ding does not disclose applying a cathodic pulse followed by electrochemical deposition. Ding only describes applying electrical current for electroplating. [See Ding, col. 3, lines 1-15] Accordingly, Applicants respectfully submit that a *prima facie* case of obviousness has not been made out by the Examiner with respect to new claim 55, and hence amended claims 26-28 and

new claims 56-58 that depend therefrom, because every critical element appearing in the claim is not disclosed by Lu in view of Ding.

Claim 6 is rejected as being unpatentable over Shingubara. Claim 6 has been amended to depend from amended claim 1, as described above. Accordingly, it is believed that the Examiner's rejection is now moot.

III. Conclusion

In view of Applicants' amendments and remarks, it is respectfully submitted that the Examiner's rejections under 35 U.S.C. §§ 102 and 103(a) have been overcome. Accordingly, Applicants respectfully submit that the application, as amended, is now in condition for allowance, and such allowance is therefore earnestly requested. Should the Examiner have any questions or wish to further discuss this application, Applicants request that the Examiner contact the Applicants' attorneys at the below-listed number.

If for some reason Applicants have not requested a sufficient extension and/or have not paid a sufficient fee for this response and/or for the extension necessary to prevent abandonment on this application, please consider this as a request for an extension for the required time period and/or authorization to charge Deposit Account No. 50-2091 for any fee which may be due.

Respectfully submitted,

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Dated: November 29, 2006

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